Use of E-Learning Functionalities and Standards: The Spanish Case

Martín Llamas-Nistal, Senior Member, IEEE, Manuel Caeiro-Rodríguez, Senior Member, IEEE, and Manuel Castro, Fellow, IEEE

Abstract—This paper shows the results of a survey performed in Spain on the different functionalities of e-learning platforms. This survey was filled in by a group of teachers, experts in engineering education from across Spain, within the scope of the Spanish Chapter of the IEEE Education Society. This paper presents their opinions on several aspects of e-learning functionalities, such as knowledge levels, levels of use, and usefulness, as well as describing the most commonly used platforms. One of the objectives of this work is to create a debate in the international community about the use of e-learning platforms and their main functionalities, the most frequently used standards, the implications for and the levels of support by institutions in their use of e-learning platforms, and in general, their advantages and disadvantages.

Index Terms—E-learning functionalities, e-learning platforms, digital repositories, standards.

I. INTRODUCTION

During the last decade, e-learning platforms (Learning Management Systems) have proliferated in the learning applications field. Their use has increased in higher education, as well as in small-, middle-, and large-sized companies. The domain of engineering education has been aware of this trend and of the application of these platforms in online, distance, blended, and traditional university education.

An e-learning platform is a software application installed on a Web server, which is used to administer, distribute, and supervise the educational activities of an organization or institution. Its main functions are to manage users, resources, and educational materials and activities, to control access, to supervise the learning process and a user’s progress through that process, and to make evaluations. It can be said that the use of information and communications technologies (ICT) in learning is being promoted through the use of e-learning platforms.

In 2009, a survey [1] on different aspects of the use of e-learning platforms in engineering education was carried out by the CESEI, the IEEE Education Society (ES) Spanish Chapter network [2]. This network is promoted by the IEEE-ES Spanish Chapter [3] and is currently composed of more than a hundred teachers in 40 universities throughout Spain, all of them strongly related to engineering education.

The main interest of this study is to learn how e-learning functionalities and standards are being used in Spain in the field of engineering education. The study covers the most commonly used e-learning platforms; their main functionalities and aspects of their use, such as knowledge levels, training, patterns of use, perception of training proficiency, usefulness, and learning curve; teachers’ perceptions of the students’ use of the different functionalities; institutional support; the use and knowledge of e-learning standards; the use of repositories; and finally, the main advantages and disadvantages of e-learning.

There are some related studies, such as [4], focused on learning tools in Europe, and [5], focused on Australia.

The paper is structured as follows. In Section II, the survey method is explained. In Section III, the main e-learning platform functionalities are introduced. Section IV describes the main e-learning standards. The results of the study are given in Section V. In Section VI, some advantages and disadvantages are discussed. The paper ends with some conclusions and implications for the future.

II. METHODOLOGY

The starting point for the survey was what questions to ask and whom to ask.

The main objective was to investigate the use of new technologies in the teaching/learning process through the e-learning platforms. After a period of reflection and discussion, and based on the experience of the working team, it was agreed that the issues in this survey would be the following.

A) Use of e-learning platforms, focusing on online versus traditional teaching, and the distribution of their use according to grade.

B) Functionalities: knowledge levels, training, use, perception of training proficiency, usefulness, and learning curve for the main functionalities of e-learning platforms.

C) Institutional support: Installation, maintenance, and updating of e-learning platforms. Training on teaching methodologies of platform functionalities.

D) Content: Being one of the most important functionalities of e-learning platforms, there is great interest in the facilities for creating content and for adapting existing content to e-learning platforms.

E) Teachers’ perceptions of students’ experience: Teachers’ perception of how students use these functionalities and the benefits they derive.

F) Standards: Actual knowledge and use of e-learning standards.
III. E-LEARNING PLATFORMS AND THEIR FUNCTIONALITIES

The first group of e-learning platforms considered for the survey was Moodle [7], Ilias [8], Dokeos [9], .LRN [10], Sakai [11], Claroline [12], and WebCT/Blackboard [13]. These were selected according to previous studies, such as [14], and a previous smaller survey of a selected group of users.

The questions on the survey were focused on the level of use of each e-learning platform for each university grade and on the traditional teaching versus online characteristic of its use.

The functionalities were selected mainly from the Edutools Site [15], some related works [16], [17], and the analysis of functionalities of previous e-learning platforms.

As a consequence, the following functionalities were selected.

— **Content delivery.** This is the most usual functionality and permits teachers to deliver content to students. There are several kinds of content and format, from text to audio or video. Nevertheless, in this functionality the focus was on the most usual content, that is, text in PDF, Word, or PowerPoint. The most refined content, such as audio or video, is classified into podcast and vodcast.

— **E-mail.** Internal e-mail is electronic mail that can be read or sent from inside an online course.

— **Tasks-Exercises.** These usually consist of some kind of material that students have to upload to the platform in response to some required activity. Normally these tasks are in PDF, Word, or similar formats.

— **Forums.** A discussion forum is a threaded online text conversation between participants, where the teachers/students can post messages and comment on other messages.

— **Mailing lists.** These are collections of names and addresses (usually the students) used generally by the teacher to send information to these multiple recipients (students).

— **Exams.** These are the typical exams used to evaluate the work of students.

— **Self-assessment.** This kind of tool enables students to assess his/her progress and knowledge level on a specific subject.

— **Surveys.** This functionality enables the possibility of performing surveys to students on different topics.

— **Groupwork.** This offers the capacity to organize a class into groups and to provide a group workspace that enables the instructor to assign specific tasks or projects.

— **Chat.** Real-time chat is a conversation between teachers/students over the Internet that involves exchanging messages back and forth at virtually the same time.

— **Calendar.** This enables students and teachers to document their plans for a course and the associated assignments in a course.

— **FAQs.** This is the typical Frequently Asked Questions service.

— **Wikis.** This is a service that allows the easy creation and editing of any number of Web pages, using a simplified text editor.

— **Blogs.** A blog (a contraction of the term “Web log”) is a type of functionality that permits an individual to show
regular entries of commentary, descriptions of events, or other material, usually in chronological order.

- **Glossaries.** This functionality lists definitions that can be looked up by the students.
- **Videoconference.** This allows two or more locations to interact via two-way video and audio transmissions simultaneously.
- **Notebook.** This enables students to make notes in a personal or private book. The personal notes can be shared with other students and/or teachers, but private notes cannot be shared.
- **Whiteboard.** Whiteboard tools include an electronic version of a dry-eraser board used by instructors and learners in a virtual classroom (also called a smartboard or electronic whiteboard) and other synchronous services such as application sharing, group browsing, and voice chat.
- **Learning paths.** This functionality, also called lessons, allows teachers to add entire lessons that guide the student based on the student’s answers. It might be helpful to think of a lesson as a kind of flowchart.
- **Student portfolio.** Student portfolios are areas where students can showcase their work in a course, display their personal photo, and list demographic information.
- **Podcast.** This is a series of audio files that can be downloaded from the e-learning platforms. This can be seen as a part of content delivery, but was considered as a separate and specific functionality.
- **Student tracking.** This is the ability to track the use of course materials by students and to perform additional analysis and reporting both of aggregate and individual usage.
- **Vodcast.** This is a series of video files that can be downloaded from the e-learning platforms. Some authors consider vodcast as equivalent to podcast, but here vodcasting was considered independently of podcasting since video is different than audio.

### IV. Standards

In general, e-learning standardization is concerned with the solution of two key problems: interoperability and reusability. Interoperability concerns the ability to work together and to communicate, and reusability concerns the possibility of exploiting a resource repeatedly in different systems. On the one hand, interoperability is supported by the specification of common interfaces and protocols, including models for the messages interchanged. On the other hand, common data models help to solve the reusability issue.

Some of the more relevant standards produced to date are listed here.

- **IEEE Learning Object-Metadata (LOM)** [18] became the first IEEE official standard for learning technologies (IEEE 1484.12.1) in 2002, based on existing proposals such as Dublin Core [19]. LOM specifies the syntax and semantics of learning object metadata, defined as the attributes characterizing a learning object in order to facilitate its management, location, and evaluation. Where applicable, learning object-metadata may also include pedagogical attributes such as teaching or interaction style, grade level, mastery level, and prerequisites. Additionally, although not explicitly stated by the LOM proposal, LOM may also be useful for other related tasks like intellectual property rights management or electronic commerce.
- The **IMS Content Packaging (IMS CP)** specification [20] is proposed to enable the aggregation of educational resources into a package that can be handled as a single unit. This aggregation may include a single course, parts thereof, or even a collection of courses.
- **ADL SCORM** [21] is an initiative of the U.S. Department of Defense (DoD) that specifies a Content Aggregation Model (CAM) and a Runtime Environment (RTE). The CAM adheres to the IMS CP specification and provides additional explicit indications and implementation guidance for packaging assets, shareable content objects (SCOs), and content organizations. The RTE defines an interface and a protocol for e-learning systems that enable the storage and shared access to state information between SCOs.
- **IMS Question and Test Interoperability (IMS QTI)** [22] specification describes a basic structure for the representation of question (item) and test (assessment) data and their corresponding result reports. Therefore, it enables the exchange of test and result data between e-learning systems as well as content authors.
- The **IMS Learning Design (IMS LD)** specification [23] was based on the OUNL EML. Its objective was to provide a containment framework of elements that can formally describe any design of a teaching–learning process. IMS LD is an integrative proposal of a number of other existing IMS specifications, such as IMS CP, IMS Metadata/LOM, and IMS QTI (among others).
- The **IMS Learner Information Package (IMS LIP)** specification [24] addresses the interoperability of Internet-based Learner Information systems with other systems that support the Internet learning environment. Learner Information is a collection of information about a Learner (individual or group learners) or a Producer of learning content (creators, providers, or vendors). The intent of the specification is to define a set of packages that can be used to import data into and extract data from an IMS compliant Learner Information server.
- **Dublin Core (DC)** [19] is a general-purpose and widely adopted metadata scheme targeted to resource location. In August 1999, the Dublin Core Advisory Committee (DCAC) formed the DC-Education Working Group (DC-Ed WG) [25] to develop and make a proposal for the use of Dublin Core metadata for the description of educational resources. Basically, its task is to propose extensions to the DC metadata set to describe this kind of resource, taking LOM and the IMS proposal as a basis.

These are some of the most relevant standards at present. In addition, there are over 40 standards and specifications proposed by more than a dozen international organizations. An updated view of e-learning standardization initiatives can be found in the Learning Technology Standards Observatory (LTSO) [26].
V. RESULTS

This section presents the results obtained in this study. They are classified as follows: (A) Use of e-learning platforms; (B) Functionalities; (C) Institutional support; (D) Contents; (E) Teachers’ perception of students’ opinions; (F) Standards; and (G) Repositories.

A. Use of E-Learning Platforms

Figs. 4 and 5 show the most commonly used e-learning platforms in Spain by university grade (educational level) and traditional teaching versus online use in each grade. In Spain, these studies are classified as the following: first grade or diplomate studies (equivalent to U.S. undergraduate), second grade or graduate studies, and third grade or doctoral studies.

Notice that Moodle [7] is clearly the most used e-learning platform in all grades, and that WebCT [13] and .LRN [10] are both quasi-equal in second place. Among other e-learning platforms used in Spain are proper university platforms (in six cases), Aula Global (3), Aula Web (2), ACME (1), eKASI (1), ecampus (1), SIFO (1), ADI (1), SWAD (1), MIT (1), GEN (1), and Drupal (1).

With respect to the online versus traditional teaching use, the online use is between 14% and 21% across the three grades, and blended learning (a mixture of online and traditional teaching) is between 9% and 14%. However, the degree of traditional teaching significantly decreases with the grade, from 60.3% in first grade, to 48.2% in second grade, and finally to 30.5% in third grade. It is also significant that the higher the grade, the greater the number of teachers who did not answer this question.

B. Functionalities

Figs. 7–12 show the results for each of the topics and functionalities selected in this paper, with the respondent giving 10 as the maximum and 0 as the minimum mark.

With respect to the knowledge level of these functionalities (Fig. 7), there is a group of functionalities with a high degree of knowledge (greater than 7): Content Delivery, E-Mail, Task-Exercises, Forums, Mailing lists, Exams, Self-Assessment, Surveys, Groupwork, Chat, Calendar, FAQs, Wikis, Blogs, Glossaries, Videoconf., Notebook, WhiteBoard, Learning Paths, Student Portfolio, Podcast, Student Tracking, and Vodcast (these last three with grades less than 4).

With respect to the training received for each of the functionalities, Fig. 8 shows that in general this was scarce: There is no functionality with a grade greater than 3.1. The lack of training is one of the most interesting results of the survey.

With respect to the training received for each of the functionalities, Fig. 8 shows that in general this was scarce: There is no functionality with a grade greater than 3.1. The lack of training is one of the more interesting results of the survey.
standing functionalities (value greater than 7), while Student Tracking, Podcast, and Vodcast are less (or almost never) used. It can also be seen that there is a clear line (value 4.0) between the more and less used functionalities.

Fig. 10 shows the perception of training proficiency for each one of the functionalities and confirms the results of the previous training topic (shown in Fig. 8): a general perception of a lack of training.

Fig. 11 indicates the perception of the usefulness of the different functionalities. The most outstanding (marks greater than 8) are Content Delivery, E-Mail, and Tasks-Exercises, followed by (marks equal or greater than 7) Self-Assessment, Forums, Mailing-Lists, Surveys, Groupwork, and Exams. On the other hand, the least useful (marks less than 3) are Podcast, Student Tracking, and Vodcast. Other functionalities with a low grade of usefulness (marks less than 4.5) are Student Portfolio, Notebook, Whiteboard, and Blogs.

Fig. 12 shows the preparation required for each functionality. This topic must be considered with care and take into account the results of the other topics, especially the level of use. If a functionality is not used, obviously the level of preparation required should be null. Therefore, the results for the less used functionalities are also the lowest in this topic, and the most used functionalities, such as Content Delivery and Task-Exercises, have a relatively high level of preparation required. However, other commonly used functionalities, such as E-Mail and Forums, do not have a similarly high degree of preparation required.

Fig. 13 indicates the extent of use of some ICT tools before using the e-learning platforms. They are Web Pages, E-mail, Forums, Wikis, and Blogs, where E-mail and Web Pages were the most used.
A key aspect in the implementation of e-learning platforms is the support that the institution provides, both through the installation, maintenance, and updating of systems and through training in the technical use and teaching methodologies for the different functionalities.

Table I shows some results for this issue, such as ease of deployment, where in general terms the institutions do provide facilities for implementation (49%) and for upgrading the platforms (64%).

Table I

<table>
<thead>
<tr>
<th>ASPECT</th>
<th>YES</th>
<th>NO</th>
<th>NO ANSWER</th>
</tr>
</thead>
<tbody>
<tr>
<td>Facilities for Implementation of Platforms</td>
<td>80 (49%)</td>
<td>29 (18%)</td>
<td>53 (33%)</td>
</tr>
<tr>
<td>Platform Update</td>
<td>104 (64%)</td>
<td>15 (9%)</td>
<td>43 (27%)</td>
</tr>
<tr>
<td>Student Training</td>
<td>31 (19%)</td>
<td>71 (44%)</td>
<td>60 (37%)</td>
</tr>
<tr>
<td>Training on Methodologies</td>
<td>53 (33%)</td>
<td>109 (67%)</td>
<td>-</td>
</tr>
<tr>
<td>Incentives</td>
<td>78 (48%)</td>
<td>64 (40%)</td>
<td>20 (12%)</td>
</tr>
</tbody>
</table>

C. Institutional Support

A key aspect in the implementation of e-learning platforms is the support that the institution provides, both through the installation, maintenance, and updating of systems and through training in the technical use and teaching methodologies for the different functionalities.

The next aspect considered was the training received by teachers on methodologies for the pedagogical use of e-learning platforms. A third of the teachers say that they have received such training, compared to two-thirds who say that they did not. Fig. 14 shows a more detailed view of the training that the institution carries out on the various educational uses of the different functionalities. Note the insufficient training that institutions provide: The best is marked at 6.5 (maximum is 10) and, in total, only five features are scored above 5.

This is one of the weaknesses of the institutional involvement: the lack of training in the methodologies of pedagogical use of the different functionalities of e-learning platforms. It is not enough to install platforms with different functionalities—it is also necessary to train teachers how to best use these functionalities from a teaching point of view. The teachers can then decide to use a functionality or not for their course. The reason for not using a functionality should not be due to ignorance of its pedagogical or technical use.

Another aspect considered is the training received by students on the use of the functionalities of e-learning platforms. This is obviously a key issue since good training implies making good use of e-learning platform functionalities. The results obtained indicate the perception that teachers have about such student training and emphasizes that this perception is negative. The majority of teachers who replied (44% of the total) say that students are not adequately trained, 19% of the total say that they are adequately trained, and 37% do not know. This is an aspect that institutions have to consider and improve.

The last aspect is related to the incentives the organization provides. 48% say their institution itself encourages the use of the platforms, 40% say it does not, and 12% do not know. Clearly, many institutions do not encourage the use of e-learning platforms.

As for the specific incentives, there is no clear consensus on which incentives there should be, and generally there is a wide variety of proposals for incentives, as can be seen in Table II.
D. Content

One of the most used functions is content delivery, as can be seen from the results in the preceding sections. This was expected since most teachers deliver some sort of material to students by some means (in person, by Web, etc.). This is why the study wanted to know the facilities available for content creation.

As can be seen in Table III, institutions generally offer training for content creation, although less than half of the teachers have received this training. Table IV shows the answers to a series of questions asked about content creation.

Most respondents create platform-specific content, not only adapting the previous content, but also increasing the amount of content delivered to students. More content is delivered to the class using e-learning platforms than was the case without e-learning platforms. Moreover, the majority is satisfied with platform-specific content. It is evident that the use of e-learning platforms promotes the creation of more and better content delivery to students.

E. Teachers’ Perception of Students’ Opinions

Another important aspect is students’ opinions. On this occasion students were not surveyed directly.

Fig. 15 indicates the value given by teachers to their perception of the extent of use of different functionalities by students. Only four functionalities score above 5: Content Delivery, E-Mail, Tasks-Exercises and Exams. Three score between 4 and 5: Forums, Self-Assessment, and Surveys. The rest of functionalities score below 4.

Of course, it is understood that the perception that teachers have is intimately linked to the use they make of those functionalities (unused functionalities cannot be used by students), and so the features listed here as the most used by students are themselves among the most commonly used by teachers (see Fig. 9).

Fig. 16 shows the valuation of the perceived degree of student satisfaction, where the most prominent features are Content Delivery, E-Mail, and Tasks-Exercises, each with a mark above 5; items with a mark between 4 and 5 are Forums, Self-Assessment, and Mailing Lists. Here, the same comments can be made as in the previous paragraph (Fig. 15).

F. Standards

As discussed, the use of standards promotes interoperability and reuse, which are two very important aspects to consider. Of the 162 teachers surveyed, only 44% (71) claimed to know of...
Fig. 16. Perception of degree of student satisfaction of functionalities (10: maximum, 0: minimum).

Fig. 17. Well-known standards.

some standard, compared to 56% (91) who were not aware of any standard.

Fig. 17 shows the rating of the degree of knowledge on the various standards (10 best knowledge, 0 minimum). The best known is SCORM, followed by LOM, IMS-CP, and IMS-QTI, all three with a similar degree of knowledge. These standards were initially thought to be the most known, and this was corroborated by the responses. In addition, there were other standards known, but clearly to a lesser degree, and therefore these have been categorized as “others.” Prominent among these are (more than one answer) IMS-LD (10 responses), IMS-LIP (4), and Dublin Core (3).

Fig. 18 shows the rating of the most widely used standards, and Fig. 19 represents the valuation regarding those considered the most useful standards. In both cases, it should be emphasized that SCORM is the most widely used and is considered the most useful. IMS-QTI is considered the second most used and most useful. Finally, in the section on “others,” both figures highlight IMS-LD (10 answers to the most used standard, and eight to the most useful standard), followed by IMS-LIP (four and two, respectively), and Dublin Core (two and three).

Questioned about the migration of courses from one platform to another, only 23% (32) answered affirmatively, compared to 77% (109) who had not migrated from any course. Of those who have made the migration, only 41% said that the migration was easy (59% admitted that it was not). Fig. 20 shows the standards used in migration, which highlights the use of SCORM and, in second place, IMS-CP.

G. Repositories

The term “Digital Repository” is used to describe a wide range of systems that provide the infrastructure for the storage, preservation, management, discovery, and delivery of all types of electronic content. These are “Institutional Repositories,” that is, repositories used by organizations such as universities to store copies of subject material (either digitalized or “born digital”) and to provide access to the members of the university or, if it is “open,” to anyone. In this case, the reutilization can be achieved by accessing the contents created by different universities.

Only 42 teachers (26%) know that their institutions have repositories, 33 (20%) know that their institutions have no repositories, and surprisingly, 87 (54%) do not know if their institution has repositories.

Table V shows some aspects of repositories: the open character of the repository, the use of contents of repositories, and introducing content into them. The low use of repositories is evident, although it is a very useful tool in principle.

VI. ADVANTAGES AND DISADVANTAGES

This section analyzes the answers to the open-ended question on the general view of e-learning functionalities: advantages and disadvantages. It was difficult to analyze and has engendered a
TABLE V
REPOSITORIES

<table>
<thead>
<tr>
<th>QUESTION</th>
<th>YES</th>
<th>NO</th>
<th>No Answer</th>
</tr>
</thead>
<tbody>
<tr>
<td>Is it an open repository?</td>
<td>24</td>
<td>4</td>
<td>(10%)</td>
</tr>
<tr>
<td>Did you use any material from repository?</td>
<td>21</td>
<td>21</td>
<td>(50%)</td>
</tr>
<tr>
<td>Did you put any material into repository?</td>
<td>25</td>
<td>17</td>
<td>(40%)</td>
</tr>
</tbody>
</table>

Main advantages are:
— the possibility of synchronous and asynchronous communication enabled by e-learning platforms;
— the possibility of delivery of, and access to, content and materials, along with their continued availability;
— flexibility, availability anytime and anywhere in all materials and features.

Main disadvantages are the following.
— Greater effort of the teacher: The majority of the teachers agreed that one of the major drawbacks is that the use of e-learning platforms requires a greater effort by teachers, as much for the creation of specific material as for the many time-consuming functionalities of the platform. Furthermore, this teacher effort is not recognized by the institution.
— Negative effects on the students: Some teachers believe that having to use and deal with a lot of information may force students to make a greater effort, and consequently discourage them. On the other hand, others believe that use of e-learning platforms can encourage students to become more passive.
— Platform support and update: Some teachers say that technical failures in the platform can seriously affect the educational process, as can poor technical support or a rapid change to new versions with different functionalities. The excessive reliance on technology by the educational process is perceived as a drawback by some teachers.
— Lack of human contact, and depersonalization: The use of e-learning platforms can lead to lack of personal contact between teacher and student.

VII. CONCLUSION

This paper shows the results of a survey carried out in Spain on several aspects of the use of e-learning platforms in engineering education: its functionalities, e-learning standards, the contents creation, institutional support, and the use of repositories. Sections V and VI gave the results of this study.

The main conclusion is that the majority of teachers use e-learning platforms with the consequence that more and better content has been created and delivered to students. Currently, it seems that most teachers have been using e-learning functionalities mainly to distribute content and to communicate with learners, without changing their teaching methods. Nevertheless, teaching methods should change in order to take full advantage of the features of the new environments [27]. At this point, there is a lack of training in the different e-learning functionalities, and it is apparent that there is a need for training in these, and in their teaching use. As stated, the reason why a teacher decides not to use a functionality should not be his or her ignorance of its pedagogical or technical use.

If the set of functionalities of which the teachers have less knowledge (Fig. 7) is compared to the level of use (Fig. 9) and perception of usefulness (Fig. 11), the following functionalities always appear: Podcast, Vodcast, and Task-Exercises are always the three most highly valued functionalities in these figures, and consequently they can be considered as the more known and more useful functionalities for teachers.

Another conclusion is the low knowledge of e-learning standards and the low knowledge and use of digital repositories. These are two key aspects to the reuse and sharing of contents, and the authors encourage training in e-learning standards and repositories to allow sharing and reuse of more and more content.

With respect to future work, the authors will continue to analyze these results, particularly the opinions of the teachers, to identify the most important questions for teachers in future surveys and to arrive at conclusions and recommendations for better use of e-learning platforms.

There are new tools emerging in e-learning, such as, for example, social networks [28] and games [29]. Their use is increasing, and as a consequence they should be taken into account in future surveys.

ACKNOWLEDGMENT

The authors wish to show their sincere gratitude to everyone who has collaborated with this survey [30], [31]. Special thanks to D. Estévez González for his helpful support on graphics development and J. Lessoff for reviewing the English.

REFERENCES
